Dynamic Design: Launch and Propulsion

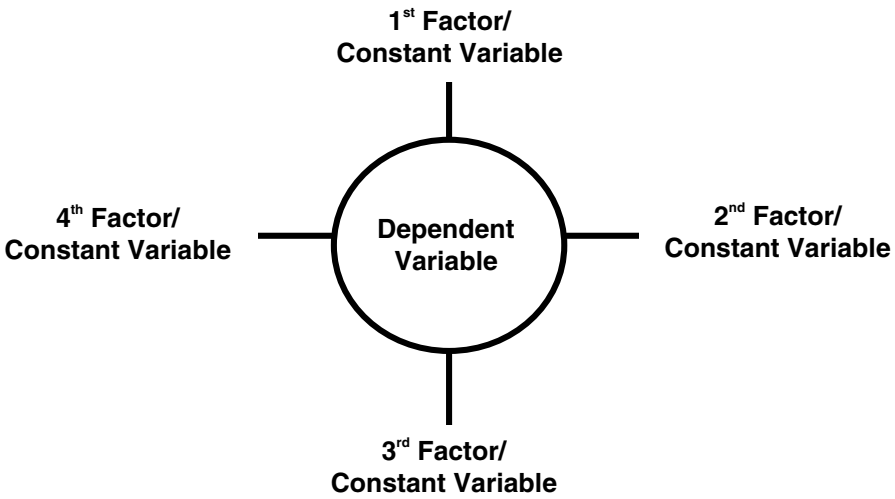
Pop Rocket Variables

TEACHER GUIDE

BACKGROUND INFORMATION

In this introductory activity, students study the concept of variables in relation to launching pop rockets. The lesson starts by having the teacher direct a discussion assessing what the students know about rockets. This allows the students to relate experiences they have had with rockets. Then students will complete a concept map for "rocket" which will allow students to demonstrate their prior knowledge about rockets. Following this, students may view clips from the movie *October Sky* to stimulate further discussion and conversation about rockets in their history. Students discuss the idea that variables are factors that are involved in an experiment. The teacher may then demonstrate how a pop rocket works using a film canister with water and an antacid tablet. Students will then use a variable wheel to make operational definitions and list all of the variables that may affect the flight of the pop rocket.

The use of a variable wheel is a technique that students can use to graphically represent the factors involved in an experiment. The variable wheel is simply a circle with the dependent variable written in the center. The spokes that extend out from this circle are factors that would affect the dependent variable. Once students have written as many factors on the spokes as they can generate, they choose one of these variables that they plan to test. The other factors listed then become variables that should be kept constant during the experiment. With the variables identified, the next step is for students to operationally define both the dependent and independent variables. This operational definition, as described in the teacher procedure, should describe how the independent variable will be manipulated and how the dependent variable will be measured.



Students will choose a variable to test, then write a research question and complete their investigation.

Following the investigation, students read the Student Text, "Variables and Operational Definitions." This text uses a Super Bowl pizza party to describe how events or items affect the ultimate outcome of a particular effort, including those events over which our control ranges from a great deal to none.

NATIONAL SCIENCE STANDARDS ADDRESSED

Grades 5-8

Science As Inquiry
- Abilities Necessary to do scientific inquiry
- Understandings about scientific inquiry

Physical Science
- Properties and changes of properties in matter
- Motion and Forces

Science and Technology
- Abilities of technological design
- Understandings about science and technology

Science in Personal and Social Perspectives
- Science technology and society

History and Nature of Science
- History of science

Grades 9-12

Science As Inquiry
- Abilities Necessary to do scientific inquiry
- Understandings about scientific inquiry

Physical Science
- Chemical Reactions
- Motion and Forces

Science and Technology
- Abilities of technological design
- Understandings about science and technology

History and Nature of Science
- Historical Perspectives

(View a full text of the National Science Education Standards.)

MATERIALS

For each group of three to four students:

- Student Activity, "Pop Rocket Variables"
- Student Handout, "Rocket Concept Definition Map"
- Student Text, "Variables And Operational Definitions"
- (Optional) Student Text, "I Can't Believe I Ate the Whole Thing"
- Plastic 35 mm film canister with an internal-sealing lid
- Effervescing antacid tablet
- Paper towels
- Water
- Eye protection
- (Optional) *October Sky* video or DVD

Teaching Tip

If you plan on showing clips from the movie *October Sky,* pre-record the segments you are going to show onto a clean VHS tape. This will allow you to hold a discussion with your class with minimal time finding the right spot.

PROCEDURE

1. Distribute the Student Activity "Pop Rocket Variables." Have students complete this sheet during this class discussion and experiment. Start this activity by asking the students to brainstorm what they know about rockets. You may want to have students work in small groups of three students and generate this list of ideas and questions before having them share. Give students time to think about this and to respond. During this time, record the students' thoughts on the board or on chart paper. If there is shared information that not everyone agrees with, record this in the form of a question. Use another area to record questions that the students may have about rockets.

2. Provide each student or group with the "Rocket Concept Definition Map" student handout. Concept definition mapping is a way to teach students how find the meaning of a concept by describing what it is, describing its properties, comparing it with other concepts, and providing examples. Prior to having the student complete this you may want to model the technique by using a word they are familiar with, like the word "book."

3. Allow students time to use their brainstorming words to complete the concept map. Circulate around the room asking questions to help students clarify why and how they are putting the concept map together.
Once students have finished with this, ask them to present their concept maps to the class. Instruct the class to ask the presenters questions to help clarify the ideas presented. Presenters should respond and defend their ideas.

Alternate Strategy Tip

Make copies of the "Rocket Concept Map" on transparencies so that students can present their maps when completed.

Or

Ask students to complete the concept definition map on chart paper.

4. (Optional) Play the opening segment to *October Sky.* This movie is about a boy who lives in a coal-mining town in West Virginia in 1957. Based on the book *Rocket Boys*, by Homer Hickam, this true story details Homer's struggles as he dreamt of sending rockets to outer space. The first scene shows people listening to the news on the radio that the Union of Soviet Socialist Republic (USSR) had launched the first human-made satellite (Sputnik). Ask students questions similar to the following:
   a. How do you think Americans must have felt after hearing the news that a cold war foe had just launched a satellite into space for the first time? (Many Americans thought we were technologically behind. This symbolized that the Soviets were more advanced than the U.S. Sputnik may have caused fear in the minds of some people.)

   If you do not want to show clips from the movie, describe the events that took place in 1967 when the Soviet Union became the first country to launch a satellite into orbit. Ask students:
   b. Why might this cause fear? (People thought that if the Soviets could launch a satellite into space, they could also launch a missile at the United States.)
   c. What was the response that Dr. Wernher von Braun made according to the radio news cast? (First, he said that there was no confirmed sighting of the satellite. Second, he said the United States was working on launching a satellite of their own.)
   d. What was the long-term response from the United States? (The United States started emphasizing the subjects of mathematics and science in the nation's schools.)

5. (Optional) Let your students listen to the sound of the beeping radio signal that Sputnik made.

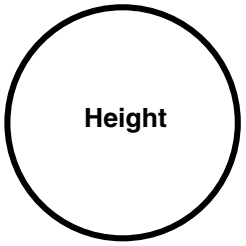
6. (Optional) Sputnik inspired Homer Hickam to experiment with model rockets. His first experience resulted in his blowing up his mother's fence. Show the segment where Homer and his friends experiment with launching rockets. Start the video at the 34 minute mark of the film where the worker says, "SAE 1020 bar stock…" Show the next 2 minutes then ask the question below. (You may want to re-show this segment after the question.)
   a. As Homer and his friends experimented with model rockets, many of his first attempts failed. This happens with rocket scientists of all ages. They learn from their experiences. What two factors were they going to change during this segment? (Reduce the mass and increase the length.)

7. (Optional) Show a short segment (one minute) starting at the 46 minute mark of the film. Ask questions similar to the following:
   a. Describe the launch of the rocket this time. (It was a successful launch.)
   b. What did they measure once it was launched? (The time of descent.)

8. (Optional) Homer and his friends were accused of starting a forest fire with their rocket. Show a one minute segment starting at 75:30. Homer uses mathematics to demonstrate that his rocket did not cause the fire.
   a. What measurement did he use that helped to determine that the rocket was not the cause? (The time it took the rocket to fall.)

9. Introduce students to the concept of a variable wheel. From what they saw in the movie clip, ask them a question similar to the following:
   a. What do we usually measure when a rocket is launched? (Most students will probably respond: "The height that the rocket will travel.")

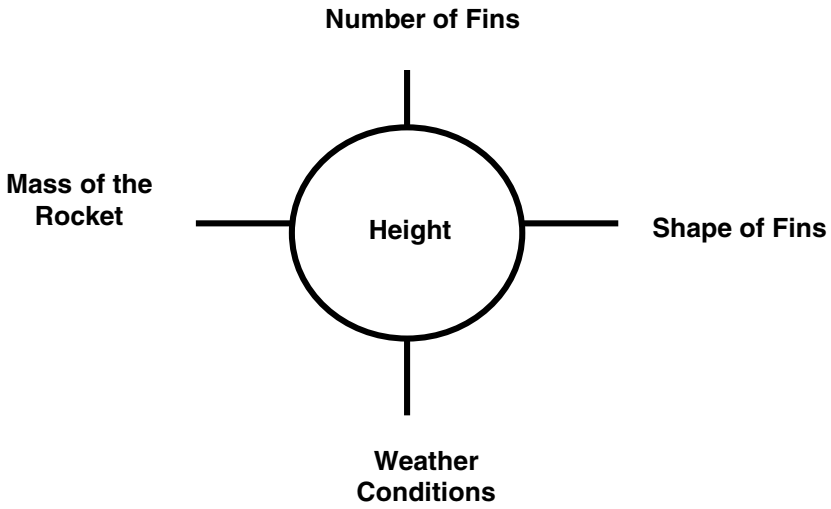
Share the following information with your students: "The variable that is measured is called the dependant variable or the responding variable because the result depends on other factors." Place the word "height" in the middle of the circle in the variable wheel.



Again referring to the film clips from "October Sky" or to students' previous experience ask:

b. What factors would be involved that would affect the height the rocket would travel? (Expect many different answers to this. Students may suggest that the amount or type of fuel would be a factor, the weather conditions, the mass of the rocket, the shape and number of fins. Some may also suggest the shape of the rocket or the nosecone.)

Explain to students that these factors that they listed are called independent variables or manipulated variables since they can be manipulated by the experimenter. Place these variables on the spokes of the variable wheel.



Ask student groups to choose one of these variables and write an operational definition for it. If students are not familiar with this concept, explain that an operational definition is the way a measurement will be performed. Give an example of an operational definition by telling students that we will measure the height of the rocket by using 3 fins, then with 4 fins, then with five fins, each time making sure that the distances between the fins are equal.

Alternate Strategy Tip

In order to give students more experiences with operational definitions, see the activities on this concept in the *Teaching Science Process Skills* resource listed in Teacher resources.

All of the variables mentioned in the variable wheel affect the height the rocket will travel. Ask students the following questions:

c. When conducting an experiment, why is it important to test one variable at a time? (Students may suggest that if more than one variable is tested at the same time, it will be difficult to determine which manipulated variable is affecting the responding variable.)
d. What variables are the most difficult to keep constant? (Students may suggest that weather conditions can change without notice.)
e. What should be done if a variable cannot be kept constant during an experiment? (Students may suggest making a note in the report describing the factors that were not kept constant and why. Other students may suggest redoing the experiment so that these variables can be kept as constant as possible.)

Share with your students that: “One way of using a variable wheel to determine a research question is to circle the manipulated variable that you wish to test. The variables not circled then become variables that are kept constant during the experiment.” Circle one of the variables in the wheel then write a research question example such as this:

Research Question: “How do the number of fins affect the height that my rocket will travel?”

Explain that in the research question, only the manipulated and responding variables need to be included. It is understood that the experimenter will try to keep the other variables constant. Also explain that the questions should not be worded in such a way that they can be answered with a “yes” or “no” response.

Teaching Tip

Examples of variables that students’ tests may include :

- the amount of water
- temperature of the water
- amount of antacid tablet used
- number of canisters used
- the size of particles of crushed antacids

10. Tell students that now they will have a chance to complete an experiment in which they get to measure how a certain variable affects the height of a pop rocket. Demonstrate how the pop rocket works by using the following procedure:
    - Put on eye protection.
    - Fill the canister one-third full of water.
    - Place one-half of an antacid tablet in the canister.
    - Snap the lid on tight.
    - Place the canister upside down (with the lid resting on the surface) on a flat surface.
    - Stand back.

11. Ask students to fill in their variable wheel for the pop rocket. They should then choose a variable that they want to test. Ask students to get into groups based on the variable they are testing (students that want to test the same variable should be in the same group). Ask the groups to write a research question and a procedure to complete the experiment. Once they have recorded their procedure, ask them to create a data table with which to record the data. Remind students that it is a good idea to test each variable with more than one trial. Circulate around the room assisting students that have questions. Look over student plans before providing the materials for the students to complete the experiments.

12. Distribute materials to the groups to conduct their experiments. Students should determine how the height will be measured. For this experiment qualitative measures would work fine. Determining methods for measuring height will be investigated further in the assessment portion of this module.

13. Ask the students to use their data to write an answer to their research question. Include this on the Student Activity sheet to be completed and handed in to the teacher.

14. Assign the Student Text, "Variables and Operational Definitions,” to be read as a review of this activity with pop rockets. Tell students to save the results from their experiments, as they will be referring to them in the next activity.

15. (Optional) Have interested students read the Student Text, “I Can’t Believe I Ate the Whole Thing.”

TEACHER RESOURCES

Film

Gordon, C. & Franco, L. (Producers), & Johnston, J. (Director). (1999). October Sky [Film]. Universal City, CA: Universal Pictures

Publications

Cramer. T. A Burning Question: When Do You Need an Antacid? [Online Available]:
http://www.familyhaven.com/health/antiacid.html

Hickam, H. (1998). *Rocket Boys.* Dell Publishing. New York.

National Aeronautics and Space Administration. (1996). Rockets: A Teacher's Guide with Activities in Science Mathematics, and Technology. Office of Human Resources and Education. Washington, DC.

Ramig. J.E. Bailer, J. Ramsey, J.M. (1995). *Teaching Science Process Skills*. Good Apple. Torrance, California.

Web sites

http://www.acg.gi.org/acg-dev/patientinfo/frame_giproblems.html
Heartburn

http://www.chem.uky.edu/courses/che115/tablets.html
Heartburn

http://www.genesismission.org/educate/kitchen/foodthought/Informative.pdf
Speaking to Inform: Building a Powerful Message

http://www.howstuffworks.com/question116.htm
How does antacid fizz happen?

http://www.hq.nasa.gov/office/pao/History/sputnik/
Fortieth anniversary of Sputnik

http://www.mindspring.com/~videosur/lscauhb.html
Heartburn